Predicting Adaptability with Social Network Analysis in a Small-scale Lobster Fishery

AVA LASSETER
University of Florida
1304 NE 19th Place
Gainesville, FL 32609 USA

ABSTRACT

When resource availability declines, small-scale producers adapt to the change in various ways. Understanding how fishermen make decisions and adapt to decreasing availability of resources is important for designing and implementing successful fisheries policy. The social relationships among fishermen are one factor that influences how individual decisions are made, as it is through such relationships that knowledge and information are transmitted. This paper presents the results of a study that examines how social resources correlate with the adaptive strategies of a group of small-scale fishermen who are experiencing resource scarcity. The paper focuses specifically on social networks as one such social resource and examines whether measuring social networks can accurately predict the adaptive strategies employed by the group of fishermen during one lobster season. The study worked with the 124 members of a lobster fishing cooperative on the north coast of the Yucatan, Mexico. Employing a social network analysis methodology, full network data was collected on the social relationships of each cooperative member. The adaptive strategy of each fisherman was determined through interviews and the collection of daily production data for one full fishing season, and then broadly classified as intensification or diversification. The analysis shows that among the population under study, social networks represent one factor that correlates with the employment of adaptive strategies, a finding that leads to a better understanding of decision-making among small-scale fishermen.

KEY WORDS: Social network analysis, adaptive strategies, resource decline, spiny lobster, Mexico \

Prediciendo la Adaptabilidad con un Analisis de Redes Sociales en la Pesca Langostera de Pequeña Escala

Cuando la facilidad para los recursos esta en declive, los productores de pequeña escala se adaptan al cambio de varias maneras. Entendiendo como los pescadores toman decisiones y se adaptan al decrecimiento de disponibilidad de recursos lo cual es importante para diseñar e implementar exitosas políticas de pesca. Las relaciones sociales entre los pescadores es un factor que influye en como se toman las decisiones individuales, así como lo es también las relaciones de conocimiento e información es transmitida entre ellos. Este escrito presenta los resultados de un estudio que examina como los recursos sociales en correlación con sus estrategias adaptables de un grupo de pescadores a pequeña escala los cuales experimentan escasez de recursos. Su papel se enfoca específicamente en redes sociales así como las redes sociales son un ejemplo y examinando si es posible a medir las redes sociales para predecir acertadamente las estrategias adaptadas, empleadas por el grupo de pescadores durante una temporada de langosta. Este estudio funciono con un grupo de 124 pescadores miembros de una cooperativa de langosta en la costa norte de Yucatán, México. Empleando una red social de metodología de análisis, lleno de toda la red de información recolectada en las relaciones sociales de cada miembro de la cooperativa. La estrategia adaptable de cada pescador fue determinada a través de entrevistas y la recolección de información de la producción diaria que muestra de esta población bajo el estudio, las redes sociales representan un factor que correlaciona el uso de estrategias adaptables. Se espera que estos resultados nos guíen a un mejor entendimiento de los factores que influyen en la toma de decisiones entre los pescadores de pequeña escala.

PALABRAS CLAVES: Análisis de redes sociales, estrategias adaptables, declive de recursos, langosta espinosa, México

Prevoir L'Adaptabilite Grace a L'analyse D'un Reseau Social dans le Cadre de la Pêche a Petite Echelle de la Langouste

Quand la disponibilité des ressources diminue, les petits producteurs s'adaptent à ce changement de façons diverses. Comprendre comment les pêcheurs prennent des décisions et s'adaptent à la diminution des ressources est importante pour concevoir et mettre en oeuvre une politique de pêche réussie. Les relations sociales entre pêcheurs représentent un des facteurs qui influence les prises de décision individuelle, ainsi que la transmission des informations et de la connaissance entre eux. Ce papier présente les résultats d'une étude qui examine comment les ressources sociales sont corrélées aux stratégies adaptatives d'un groupe de petits pêcheurs faisant face à une pénurie des ressources. Le papier se concentre spécifiquement sur des réseaux sociaux et examine si de tels réseaux sociaux peuvent précisément prévoir les stratégies adaptatives employées par un groupe de pêcheurs pendant une saison de pêche à la langouste. L'étude concernait 124 membres d'une coopérative de pêche à la langouste sur la côte nord du Yucatan, Mexique. En faisant appel à une analyse méthodique, l'intégralité des données du réseau concernant les relations sociales de chaque membre de la coopérative a été récupérée. La stratégie adaptative de chaque pêcheur a été déterminée à travers des entretiens et des données de production quotidiennes pour une saison pleine de pêche puis classifiée grossièrement comme « intensification » ou « diversification ». L'analyse montre que parmi la population concernée par cette l'étude, les réseaux sociaux représentent un facteur qui se corrèle avec l'usage de stratégies adaptatives, une découverte qui mène à une meilleure compréhension de prise de décisions parmi les petits pêcheurs.

MOTS CLÉS: Réseau social, stratégies adaptatives, déclin des ressources

Networks, Strategies, and Scarcity: Using Social Network Analysis to Identify Influential Actors in a Small-Scale Fishery

Declining resources is a problem currently faced by small-scale fishers all over the world. As marine resources continue to decline, effective policy is needed not only to protect fish stocks but also to protect the livelihoods of fishers who depend on these resources.

Policymakers have different approaches to the design and implementation of policy just as the fishers whose behavior is to be modified by such policy will vary in their degree of compliance. Policymakers may design and implement policy without consulting local resource users and expect compliance or rely on officials to enforce regulations. Alternately, policymakers can involve local resource users in the design and implementation of policy, an approach that is receiving much recent attention. When local resource users are involved in the process of managing their resources, resulting regulations are more likely to be more appropriate to local settings. Also, by including communities of resource users, greater compliance may be achieved.

But how do policymakers decide who to approach in a community and who they will involve in the decision-making process? Policymakers may not be familiar with the internal social dynamics of a community of fishers. Logic may then dictate that managers approach those fishermen who appear to be the most successful. However, indicators of fishing success in terms of wealth and fishing production may not indicate the most socially central individuals. The research presented here offers another approach to identifying the most socially influential individuals in a group of resource users. Then, by involving such individuals and getting them on board with the design of new management regulations, more appropriate policy may be designed and greater compliance will be achieved.

Research Site

This research was conducted in San Felipe, a fishing community on the north coast of the state of Yucatán, Mexico. I have spent approximately 15 months working with the 123 members of the fishing cooperative. The fishermen are small-scale, defined here based on the boat owner being both the owner of the means of production and also the captain that is directly engaged in the fishing activity. The fishermen stay near shore, fishing in 24' fiberglass open hull boats, most with an outboard 60hp motor. Fishing activity is limited to day trips with a typical crew of three men.

The primary resource of the fishermen is spiny lobster (*Panulirus argus*), which is caught by diving on compressed air, using hookah not SCUBA. Octopus (*Octopus maya*) and red grouper (*Epinephelus moro*) are also caught while diving although this practice is illegal. Legal fishing of these species mandates alternate fishing equipment (*jimba* and long-lines, respectively).

The fishermen claim that lobster harvests are decreasing each year. They cite an increasing number of new fishermen and boats as responsible for the decline. Many also complain about fishermen who take undersized lobsters or catch lobsters out of season for sale on the black market as also contributing to the decline. Some blame off-shore fishers for harvesting all the large lobsters with traps before these individuals can reach the community's near shore fishing grounds. In an interview conducted in 2005 with a random sample of 43 cooperative members, nearly all agreed that the fishery was declining and that there would be little fishing in a few years time (Lasseter 2006).

In response to the fishermen's perception of a bleak future for the fishery, some have begun to intensify fishing effort, accepting greater risk and diving in waters deeper and farther from shore. This strategy results in a greater frequency of dive accidents such as decompression sickness. The divers also engage in illegal practices such as spearfishing for grouper and hogfish, as well as gaffing octopus. Other fishers elect to diversify their livelihood strategies by investing in ranches or looking for wage labor on shore. Everyone acknowledges the need to curb the practices of illegal harvesting, taking undersized lobsters, and fishing out of season, yet the fishermen claim to be powerless to affect change amongst themselves. Again, I am suggesting here that to affect change, new policy and practice must have the support of the key people in the social network, as they are the leaders and have the capacity to influence the social behavior of the group.

METHODS

In order to identify the most socially central individuals, I first collected whole network data on the social relationships of each cooperative member. Whole network data means that I interviewed each and every member of the population, in this case, all 123 members of the fishing cooperative. I asked each fisherman, individually, to name five other members of the cooperative who they would go to in different situations. I provided a laminated list of all the cooperative members' names and nicknames to be used during the interview as a memory aid, if necessary.

The situations were as follows: Tell me five cooperative members you would go to (1) to talk to about the cooperative [Coop Talk], (2) to talk to about politics [Politica], and (3) to talk to about fishing [Pesca].

With the resulting data, I constructed a binary adjacency matrix for each of the questions, in which each fisherman was represented in the same order in both the rows and columns. With these matrices, I was then able to perform various social network analyses using the software package UCINet (Borgatti *et al.* 2002).

In addition to the social relationships between people, I also wanted to know things about each person; this is the

attribute data. Thus, I also collected data about each of the fishermen including whether they own a boat and their investment in fishing activity and equipment. I also recorded the daily production of each fisherman for an entire fishing season (July 1 2007 to June 30 2008), in order to examine fishing intensity. (The lobster season begins July 1 and closed on January 31, one month earlier than the state mandated end of season. Production data continued for the duration of the year in order to examine who continued to fish, which species and what quantities the fishermen harvested when unable to dive for lobsters.) Production data was provided by the cooperative and did not rely on the memory of the fishermen. Because of the high value and lack of black market buyers, all legal size lobsters are sold to the cooperative. Although I observed undersized lobster landings, it was not possible to determine the quantity. The collected attribute data was added as a separate matrix describing each fisherman.

Analysis

First, I wanted to see if there was a similar structure across all three matrices. That is, I wanted to see how similar the three matrices are to each other and whether there is a common structure. This would tell me how analogous the scenarios are to one another. There is a statistical analysis that will run correlations on each possible pair of matrices, called QAP. Using UCINet, I ran a QAP correlation on the (symmetrized) matrices in order to examine whether there was a common structure to all four networks. The results give a Pearson's r value for each pair of matrices (Table 1).

Table 1. Summary data for the QAP analysis showing the Pearson value for each possible pair of matrices.

QAP results for:	
Pesca * Coop Talk	0.322
Politica * Coop Talk	.0308
Politica * Pesca	0.258

Because this data is relational, that is, it is data about the relationships among the informants, a lower R value can be accepted as significant. Usually, we would want to see 0.4, which is considered a strong value for a Pearson's correlation. So, I can see that there is something going on, there is a common structure although it is not very strong. But, because I got a very low p-value for each correlation, these results were not arrived at by chance. Also, what this tells me is that who the fishermen talk to about fishing is not necessarily who they talk to about politics, for example.

The next step was to visualize each network using NetDraw (Borgatti *et al.* 2002). The principal components of the visualized network need to be defined. First, the shaded shapes in the figures (see Figure 1) represent people and are called 'nodes'. These shapes are coded to represent boat ownership and whether or not an individual works as a diver or works as a non-diving crew (key: diamond-circle). The lines between all of the shapes represent ties between people with arrows pointing in the direction of the ties. Here, you can see that the network is very cohesive. When I show you the network about talking politics, it is far less cohesive and you will see isolates (nodes that have no ties) and pendants (nodes that have only one tie to the network). The position of the nodes on the screen is determined by the algorithm of the program that tries to push some people together and others apart.

In addition to the different shapes representing some attribute of the nodes, I also added a centrality measure called "degree centrality." This is a measure of how many ties each node has. I coded the nodes for centrality where the larger the nodes in each of the matrices, the more prominent that individual is. That is, they may have more social prestige for that particular scenario.

Finally, I coded the color of each node according to an indicator I determined for wealth and lobster production for one season. In each of these graphs, greater wealth and greater production are represented in a darker node and the lighter nodes represent less wealth and less lobster production. On the production slide, those nodes coded in red represent the elected officials of the cooperative and local government who are not actively fishing for the duration of their elected term in office. (I expected these individuals to be more central than they are.

Next, if we take a look at each of the matrices for each question, we can begin to analyze who are the most central actors in each network. In the first (Figure 1), one can see that clearly #7 and #31 are the most central, although neither is among the most wealthy, nor has the highest production (Figure 2). Based on my ethnography in the community, I can say that each of these individuals has played a role in the leadership of the cooperative in the past, yet while they remain socially important, other past elected figures have not.

Looking at the second question (Figures 3, 4), the same individual stands out, #7. This time, #31 has practically disappeared. He was important to talk to about the cooperative (Figures 1 and 2), but not as respected to talk to about fishing. When talking about fishing, #1 has now assumed a greater importance, but he was not as popular to talk to about the cooperative. (#1 also has served as an elected official.). Again, we can see that the current elected officials are not necessarily very central in the network.

The final pair of matrices reveals a less cohesive network (Figures 5, 6). The less than perfect correlation in the structures of the different networks should be apparent. One can now see examples of the isolates and pendants mentioned earlier. However, even though this network appears far less cohesive, #7 is, once again, very central.

Also central is #8, the brother of #7. #8 is also known as someone who loves to talk politics. He is very young and quite charismatic, as is his brother. There is a third brother who is one of the current elected officials and as one can see, he plays a very minor social role.

The results of the preceding figures are interesting because although the QAP correlation revealed a correlation not found by chance, there was not a really strong correlation among the matrices. Yet, there are some consistencies. Namely, one individual is clearly the most central in each matrix. I also want to point out that it is important to have ethnographic data to explain the patterns that appear in the networks. Social network analysis is a way to systematically examine the structure of a network, but the value of the analysis requires an intimate knowledge with the individual actors, and their particular lives, as well.

So, why is #7 the most central actor in the network? He has a high degree of centrality across each of the scenarios, yet he is not the wealthiest nor the biggest lobster producer. During the year of data collection, he did not even own his own boat, although he has owned one in the past. This individual, a married man in his early 40s, is well-liked and charismatic. He is very socialable. He is regarded as being an honest man, although not necessarily good at managing his own money. In the community, there is a stigma attached to those individuals who are seen as more wealthy; they are often accused of being stingy; of only eating eggs at home, for example. So, might this individual's lack of money management skills actually serve to preserve his social prestige by shielding him from jealous criticism?

CONCLUSION

In conclusion, the social relationships among fishermen are one factor that influences how individual decisions are made and some individuals within a group will invariably be social leaders. By consulting with such individuals in the design and implementation of new policy to conserve declining resources, better compliance may be achieved. Fisheries managers need to be aware that managing people is an integral part of designing successful fisheries policy. If you implement policy without the support of the resource users, you will likely face an uphill and expensive battle to achieve compliance. It is important to integrate the resource users from the beginning stages of designing policy, which means from the stage of where the problem is identified.

It is also important to point out that in order to better understand social relationships, it is important to understand the historical and contemporary context to really get at their significance. It is important to work personally with resource users in order to understand how problems are perceived and decisions made. Here, #7 is definitely the most central. He has been a politically instrumental individual, and that affects his involvement in fishing now. So, we don't want to just use indicators of wealth or productivity to identify key figures in a network. To really gain community participation, it would be best to identify the most structurally important individuals in a network,

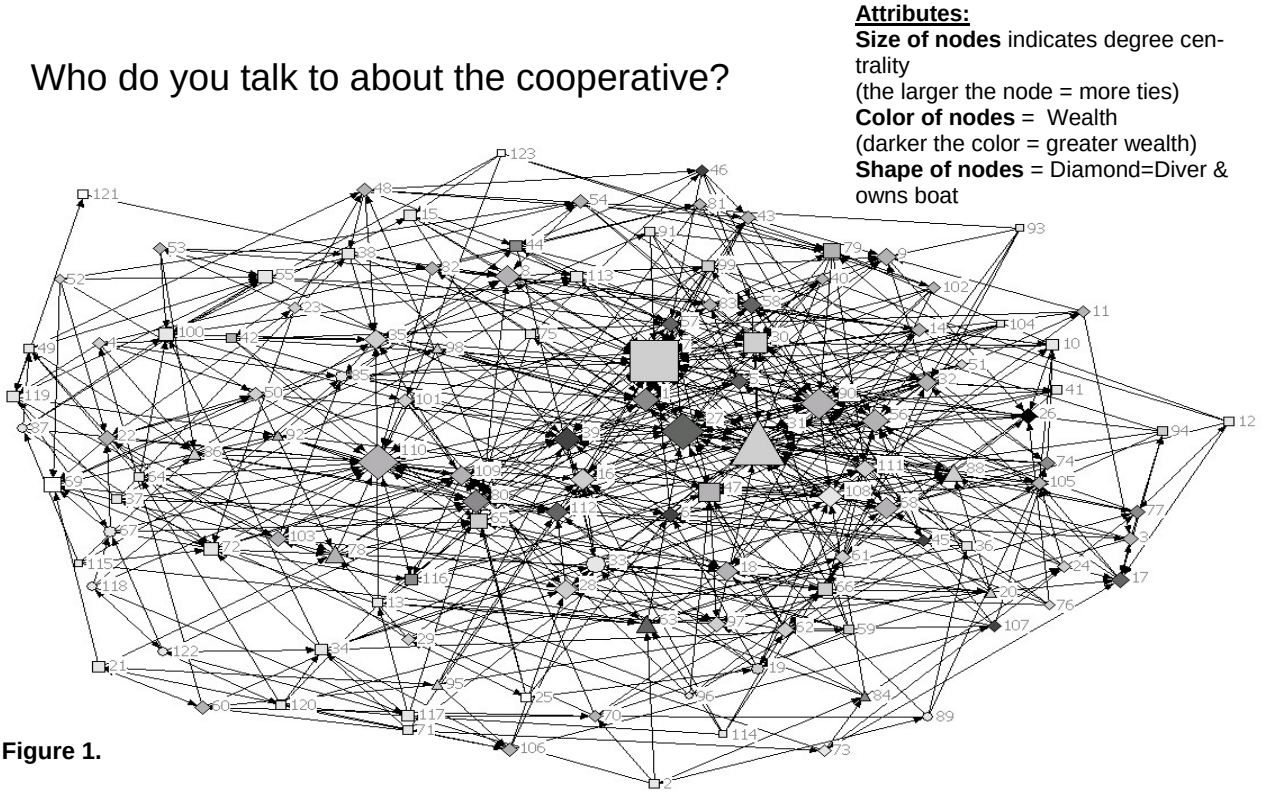
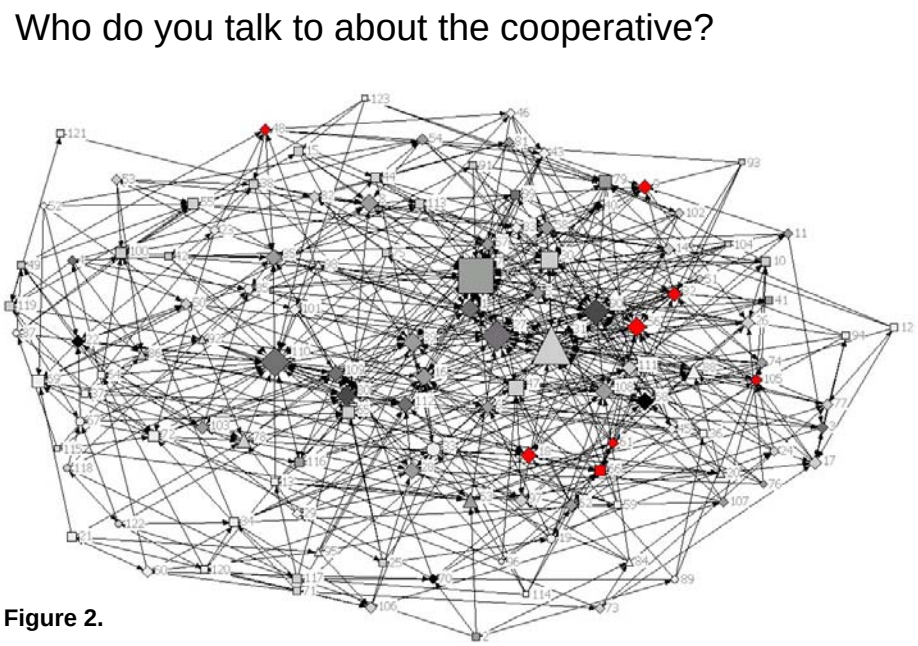


Figure 1.

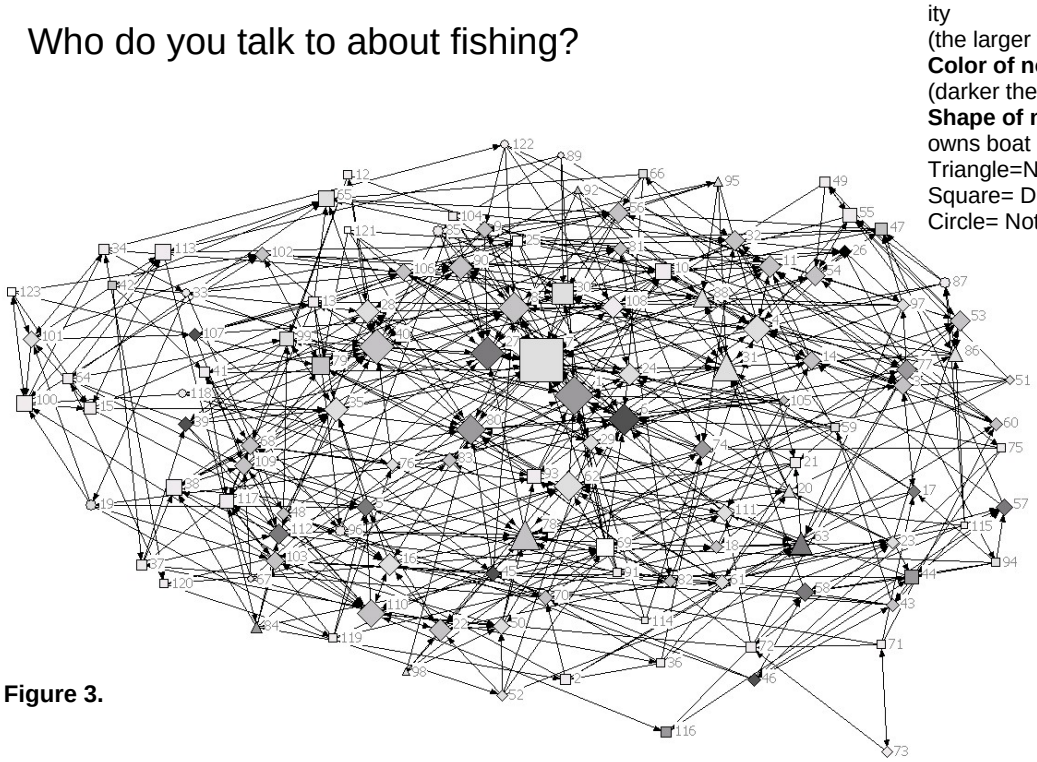
gain their support and their insight, and let them help affect change through the entire network.

It is difficult to reduce the individual circumstances of each cooperative member to numbers, but it is also important to try to find systematic ways with which we can present such particular social information to policymakers. This study, in a way, is an attempt to bridge these two goals: to more accurately present the socio-cultural factors of life in a small-scale, marine resource dependent community, but to present this life in a way that is possible to integrate into policy making. Although time intensive, this method demonstrates the development and application of a social measurement that can identify individuals of influence among a population. With the support of such individuals, it is hoped that policy makers may better understand how small-scale producers make decisions when faced with resource decline.



Attributes:
Size of nodes indicates degree centrality
(the larger the node = more ties)
Color of nodes = Lobster Production
(darker the color = greater production)
Shape of nodes = Diamond=Diver & owns boat
Triangle=Not a diver but Owns boat
Square= Diver but does not own Boat

Figure 2.



Attributes:
Size of nodes indicates degree centrality
(the larger the node = more ties)
Color of nodes = Wealth
(darker the color = greater wealth)
Shape of nodes = Diamond=Diver & owns boat
Triangle=Not a diver but Owns boat
Square= Diver but does not own Boat
Circle= Not a diver & does not own

Figure 3.

Who do you talk to about fishing?

Attributes:
Size of nodes indicates degree centrality (the larger the node = more ties)
Color of nodes = Lobster Production (darker the color = greater production)
Shape of nodes = Diamond=Diver & owns boat
Triangle=Not a diver but Owns boat
Square= Diver but does not own Boat
Circle= Not a diver & does not own boat

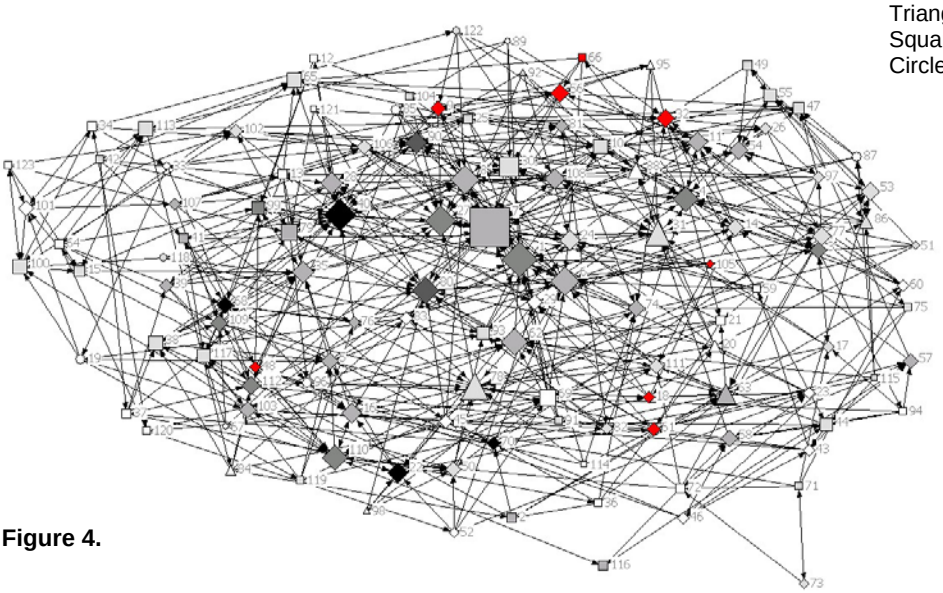


Figure 4.

Who do you talk to about politics?

Attributes:
Size of nodes indicates degree centrality (the larger the node = more ties)
Color of nodes = Wealth (darker the color = greater wealth)
Shape of nodes = Diamond=Diver & owns boat
Triangle=Not a diver but Owns boat
Square= Diver but does not own Boat
Circle= Not a diver & does not own boat

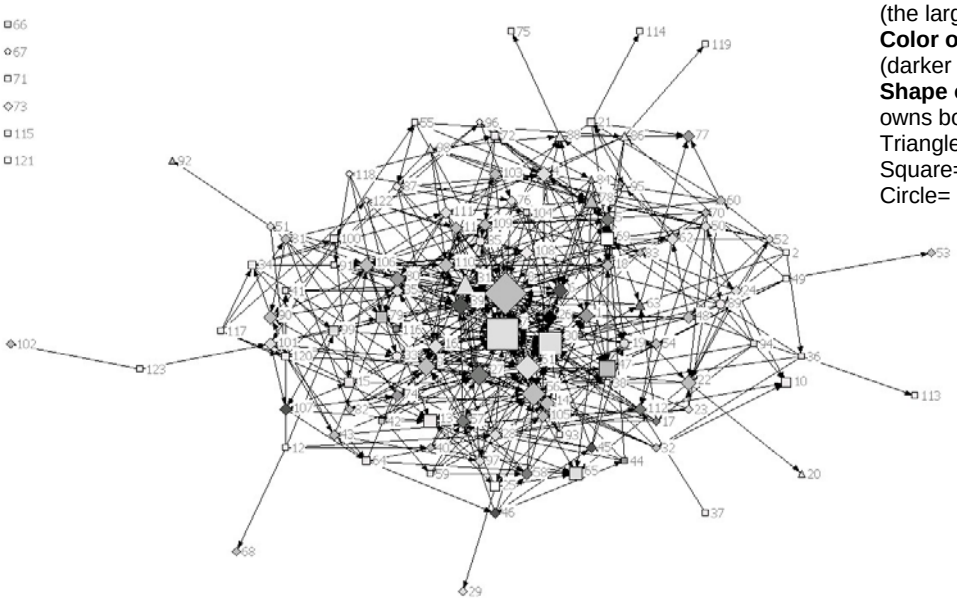
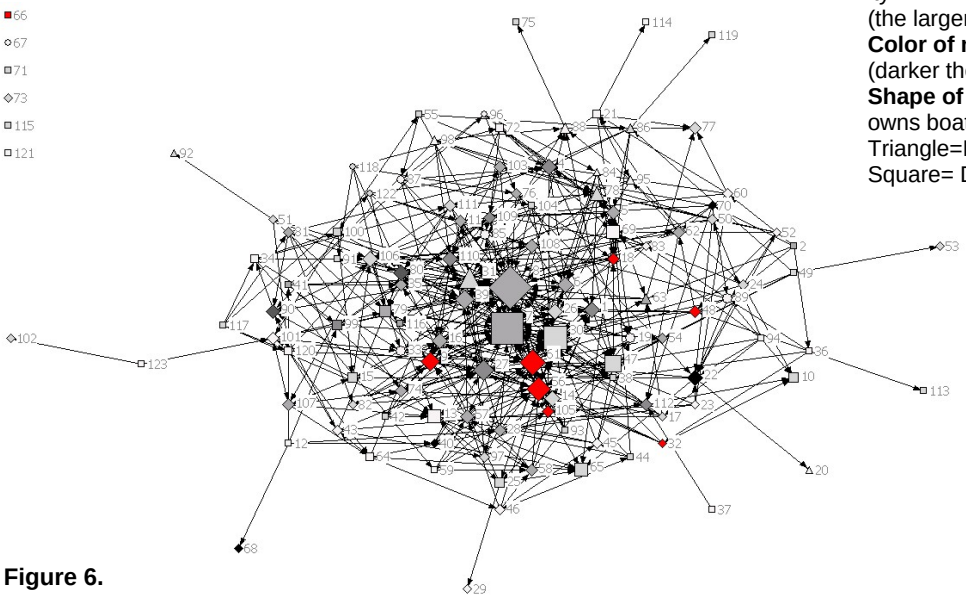


Figure 5.

Who do you talk to about politics?



Attributes:
Size of nodes indicates degree centrality
(the larger the node = more ties)
Color of nodes = Lobster Production
(darker the color = greater production)
Shape of nodes = Diamond=Diver & owns boat
Triangle=Not a diver but Owns boat
Square= Diver but does not own Boat

Figure 6.

LITERATURE CITED

Borgatti, S.P., M.G. Everett, and L.C. Freeman. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Lasseter, Ava. 2006. "'Lobsters are like Gold': Perceptions of resource access and management in a Mexican spiny lobster fishery" M.A. Thesis. University of Florida, Gainesville, Florida, USA. 180 pp.